II. PRICE INDEXES--AN OVERVIEW

In Section I, it was indicated that a price index is based on a transformation of prices that are then composited and the comparison of the composited values over time (or space). It was further indicated that one way to transform prices is to express the prices as rates of change. This section uses that method to illustrate how price index are formed. So as not to be too technical, the discussion presented here is done mostly with arithmetical examples. After showing how price indexes are formed, this section will show how items are *linked* when new items replace old items, how price indexes are *chained* when an entire array of items is replaced, how indexes are *re-referenced* when the reference base of the index changes, and then how the index is *rebased* when the weights are changed. Each of those concepts is used in constructing the ASITPI and plays an important role in the discussion of the ASITPI in Sections III.

II-A. Constructing a Price Index

The first thing that is needed in forming a price index is, as Section I has already indicated, prices. Frequently, price data will be difficult to acquire, or the data will be so numerous that various sampling techniques will have to be used to acquire them. For the purposes of this section, it will be assumed that the price data are available for the items for which a price index is being constructed. Section III contains a description of the way in which price data are acquired for the ASITPI.

Suppose, then, that the items for which price indexes are being to be formed are apples and oranges and that the following are known:

1) their prices in the current period and the previous period which are as follows (the description "period 1" and "period 2" will be used in the up-coming sub-sections):

		previous period (period 1)	current period (period 2)
oranges	(dollars per pound)	1.50	2.25
apples	(dollars per dozen)	1.00	1.20

2) the cost of purchasing apples and oranges in each period is as follows:

	previous period (period 1)	current period (period 2)
oranges	25	27.0
apples	5	8.4

3) the quantities purchased (which are implicit from 1 and 2, and can be derived by taking the cost of purchasing oranges and apples in each period and dividing that cost by the respective item and period prices).

As Section I indicated, the study of the joint price behavior of apples and oranges requires the formation of a price index. Just using the prices of each does not yield a meaningful result. That can be seen from the prices used here. Not only are the prices for the different products different, but their units of measurement are different. One is in pounds while the other is in dozens. Hence, the only meaningful way to study the combined behavior of both prices is by transforming the prices into comparable units and then composite them.

One of the ways Section I mentioned to transform the prices is to convert each price into a rate of change. For index numbers, a slight variant of the rate of change is used. It is to transform the prices into *price relatives* which is the rate of change ...

one and then express them as multiples of one-hundred. An index can then be formed by compositing the relatives in some way.

To see how a price index can be formed from the data presented here for apples and oranges, we will demonstrate how the relatives are formed and then the various averages of the individual of price relatives that can be computed. The first step, then, is the computation of the price relatives, which from the data presented earlier are:

for oranges:

$$150 = 2.25/1.50 \times 100;$$

for apples:

$$120 = 1.20/1.00 \times 100.$$

After the price relatives have been derived, they have to be composited so as to be able to derive the overall index. They can be composited by taking a simple arithmetic or they can be composited by taking a geometric average. In the first case the overall index would be $135 = (150 + 120)/2$, and in the second it would be $134.2 = 150^{1/2}120^{1/2}$. In the absence of alternative information, either of those is the best that can be done.

Suppose, though, that the user of the price index is a purchaser of apples and oranges. Then the user might want to composite the price relatives by putting more weight on one of the relatives as opposed to the other. One way the purchaser could do that is by compositing the price relatives of apples and oranges using his purchasing patterns; but which purchasing pattern to use: current purchases or previous purchases? Here, the purchasing patterns from the previous period are assumed to be the ones used. Below purchasing patterns from the current period will be used to illustrate another way of compositing relatives.

If purchasing patterns for oranges and apples from the previous period are used to composite the price relatives, then the respective weights of the relatives would be:

$$25/(5+25) = .833 \text{ for oranges;}$$
$$5/(5+25) = .167 \text{ for apples.}$$

The current period price index for the combination of apples and oranges would then be computed as follows:

$$.833 \times 150 + .167 \times 120 = 145.$$

The result, 145, is the price index of apples and oranges in the current period relative to the previous period. It indicates that the combined *increase* of the prices of apples and oranges from the previous period is 45 percent.

In the derivation of the price index, the use of the previous period's purchasing patterns has placed a heavier weight on the price relative of oranges than on the price relative of apples, as say compared to the simple unweighted average. Hence, the price index based on those purchasing patterns is closer to the price relative of oranges than it is to the price relative of apples and it is clearly different from the simple unweighted average as well. The use of purchasing patterns, though, provides information that is absent in the unweighted average. It is that the index of 145 indicates that the cost of purchasing of apples and oranges would have increased by 45 percent from the previous period to the current period if no change in purchasing patterns occurred other than a price change.

To see that, let us multiply the cost of the individual purchases of apples and oranges from the previous period by the respective price increases and compare the result to the cost of the previous period's purchases. The cost of current purchases assuming no change in spending patterns, would be:

$$25 \times 150/100 = 37.5 \quad \text{for apples;}$$
$$5 \times 120/100 = \underline{6} \quad \text{for oranges;}$$
$$43.5 \quad \text{total cost of purchases}$$

The increase from previous period would be:

$$43.5/30 \times 100 = 145.$$

For the user of a price index derived by compositing the price relatives based on the previous period's purchasing patterns, the index provides the information on how much it would cost to continue to make the same purchases if the only thing that happened was that the prices changed. Put another way, the price index so derived indicates how much it would cost to make last period's purchases of oranges and apples with the current period's prices, relative to what it actually cost to make last period's purchases of oranges and apples.

The kind of price index derived here, which is based on purchasing patterns of the previous period, is termed a *Laspeyres* index. At the publication level of the index, the ASITPI is a Laspeyres index.

An alternative index can be derived by using weights based on purchasing patterns of the current period. That kind of index is termed a *Paasche* index. The Paasche index tells us how much it actually cost to make this period's purchases of oranges and apples relative to what it would have cost to make this period's purchases of oranges and apples in last period's prices. The Paasche index is not used for the ASITPI, but for reasons to be explained below, it is used in combination with the Laspeyres below the publication level of the index for the material components of the index. Hence, to understand the combined index, the steps taken to derive the Paasche will now be illustrated.

$$
\begin{array}{rrl}
25 \times 150/100 = & 37.5 & \text{for apples;} \\
5 \times 120/100 = & \underline{6} & \text{for oranges;} \\
 & 43.5 & \text{total cost of purchases}
\end{array}
$$

The increase from previous period would be:

$$43.5/30 \times 100 = 145.$$

For the user of a price index derived by compositing the price relatives based on the previous period's purchasing patterns, the index provides the information on how much it would cost to continue to make the same purchases if the only thing that happened was that the prices changed. Put another way, the price index so derived indicates how much it would cost to make last period's purchases of oranges and apples with the current period's prices, relative to what it actually cost to make last period's purchases of oranges and apples.

The kind of price index derived here, which is based on purchasing patterns of the previous period, is termed a *Laspeyres* index. At the publication level of the index, the ASITPI is a Laspeyres index.

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25 x 150/100 =	37.5	for apples;
5 x 120/100 =	6	for oranges;
	43.5	total cost of purchases

The increase from previous period would be:

$$43.5/30 \times 100 = 145.$$

For the user of a price index derived by compositing the price relatives based on the previous period's purchasing patterns, the index provides the information on how much it would cost to continue to make the same purchases if the only thing that happened was that the prices changed. Put another way, the price index so derived indicates how much it would cost to make last period's purchases of oranges and apples with the current period's prices, relative to what it actually cost to make last period's purchases of oranges and apples.

The kind of price index derived here, which is based on purchasing patterns of the previous period, is termed a *Laspeyres* index. At the publication level of the index, the ASITPI is a Laspeyres index.

An alternative index can be derived by using weights based on purchasing patterns of the current period. That kind of index is termed a *Paasche* index. The Paasche index tells us how much it actually cost to make this period's purchases of oranges and apples relative to what it would have cost to make this period's purchases of oranges and apples in last period's prices. The Paasche index is not used for the ASITPI, but for reasons to be explained below, it is used in combination with the Laspeyres below the publication level of the index for the material components of the index. Hence, to understand the combined index, the steps taken to derive the Paasche will now be illustrated.

Many of the steps for deriving the Paasche, at least superficially, follow the steps taken in deriving the Laspeyres. Some, though, do not as will be demonstrated.

The first step taken in deriving the Paasche, which is the same as for the Laspeyres, is to compute the price relatives. Because that has already been done above for the Laspeyres, it will not be duplicated here.

Then next step, which looks the same but is not, is to compute the weights. The reason it is not is that the Paasche uses current period weights while the Laspeyres uses previous period weights and the difference in weights leads to different outcomes for the two types of indexes. The weight computation is as follows:

27/(27 + 8.4) = .76 for oranges;
8.4/(27 + 8.4) = .24 for apples.

After the weights have been computed, the next is *not* to compute the index (unlike the case of the Laspeyres). Rather, the next step requires a re-computation of the weights. That is because the weights are in current prices while the price relatives are relative to the previous period's prices. Multiplying the relatives by the weights does not yield what is needed, which is an equivalent restatement of current purchases in previous period prices. There are two options here. One is to use the weights directly by inverting the price relatives. (That would be the equivalent of restating current purchases in previous period prices; the index computed that way would then have to be inverted to get the price change from the previous period to the current period.) The other option is restate the weights in a way that makes them equivalent to being expressed in terms of prices of the previous period. Here, the second option will be illustrated which is as follows:

$$1.5/2.25 \times 27 = 18 \text{ for oranges}$$
$$1/1.2 \times 8.4 = 7 \text{ for apples}$$

The restated weights are then as follows:

$$18/(18 + 7) = .72 \text{ for oranges;}$$
$$7/(18 + 7) = .28 \text{ for apples.}$$

After the weights have been restated, the final step in the computation of the Paasche index, which does resemble the computation of the Laspeyres, would then be as follows:

$$.72 \times 150 + .28 \times 120 = 141.6.$$

For a simple two period index, such as the one in the example presented here, it does not matter that much which period's purchasing patterns are chosen (except if there is a large swing in those patterns). That is, if the notion of the direction of time were absent, then the Paasche and Laspeyres indexes would appear as two variants of the same formula. Indeed, the Paasche has been sometimes called a backwards Laspeyres. On the other hand, when multi-period indexes are being computed, as in the cases of the CPI or the PPI or the ASITPI, it does matter. In those cases, using a Laspeyres means not having to continuously change the weights of the index. By contrast, using a Paasche index would mean always having to change the weights of the index and that is another difference between the two kinds of index formulations.

Of course, even for a Laspeyres index, it will be necessary to change the weights of the index. That is because, over time, purchasing patterns change sufficiently so that the price changes being measured by the index become less and less relevant to the user. When the weights are changed, "chaining" methods are used which do not allow the change in weights to affect the computation of the price index. Such chaining methods, which are used for the ASITPI, are described in Section II-B (and indirectly in II-D).

Despite the benefits from chaining, there is a drawback that can arise from it when there is price volatility. It is that the index is subject to *drift*. That is, it drifts away from its "true" value. Both the Paasche and Laspeyres are subject to that kind of drift. In general, the Laspeyres will drift up and the Paasche will drift down. For the ASITPI, the part of the index where drift will most likely occur is in the material components of the index. That is because indexes for those components are produced by annual chaining and the possibility for price volatility always exists in that portion of the index.

One way to avoid drift due to chaining is to use what is termed a *superlative* price index. There are a variety superlative price indexes. The one that has been chosen for the ASITPI is the *Fisher's Ideal*. It is a geometric average of the Paasche and Laspeyres. Insofar as the Paasche drifts down and Laspeyres drifts up, the Fisher's Ideal, being a geometric average of the two, should produce an index that does not drift. The Fisher's Ideal is used for computing price indexes in the GDP.

II-B. The Linking and Chaining of Price Indexes

For an industry undergoing technological change, one of the more severe problems encountered in producing a multi-period price index is the turnover of items purchased. That turnover makes it difficult to acquire prices for the items that have disappeared, especially when the index is a transactions price index as the ASITPI is. The methodology used for "acquiring" the price of a good that has disappeared is to substitute the price of another good for it and track the price of that good in its place. The substitution of the price of the new good for the discontinued one is called *linking*. The intent of linking is to introduce the price of the new good in the index without affecting the level of the index. When the method is extended to an entire basket :

purchases it is called *chaining*. The BSTPI always made a sharp distinction between chaining and linking, the ASITPI does not.

The reason the ASITPI does not make a sharp distinction between the linking and chaining is a result of rapid technological change, particularly in the material components of the index where the actual item pricing is done. Because of the rapid turnover that arises as a consequence, the procedure used for the ASITPI was to go to a method of annual changes in the basket of the materials that is used in forming the material component price indexes. In effect, for the ASITPI, chaining and linking have become synonymous. But the concept of chaining can be best understood by understanding first the concept of linking. Hence, linking will be discussed first. It will then be followed by an abbreviated discussion of chaining.

The easiest way to understand the concept of linking is to illustrate it. To do that, the data from the apple-orange example will be used with a third, earlier, period added to them. First, what will be illustrated is how the price of a single item can be converted to a price index by linking the price to itself and then what will be illustrated is how a price index can be formed from it by linking it to another item.

In using the apple-orange example from II-A, the terms period 1 and 2 will be used in place of "previous period" and "current period." Also, the term "base period" will be used for the period prior to period 1. Recall, then, from II-A, that the price of oranges in period 1 was 1.50 while the price relative of oranges from period 1 to 2 was 1.5. Suppose, now, that in the base period the price of oranges was 1.2. A price index of oranges relative to the base period to period 1 would be as follows:

$$1.5/1.2 \times 100 = 125.$$

The price index for period 2 is formed by *linking* the price index for period 1 by the price relative of oranges between period 1 and period 2 as follows:

$$125 \times 1.5 = 187.5.$$

Suppose, though, oranges were not in the index in period 2, and suppose further that in period 1 grapefruits were substituted for oranges. Suppose further, that at the time of the substitution, the price of grapefruit was \$10 per dozen while in period 2 its price was \$13 per dozen. (Implicitly, it is being assumed in this example that the price of oranges becomes unavailable because oranges are no longer bought; an unlikely occurrence for oranges, but a likely occurrence for different kinds of switches.) The price relative of grapefruits from period 1 to period 2 would then be as follows:

$$13/10 = 1.30.$$

To link in the price of oranges, that relative of 1.30 is multiplied by the price index of oranges in period 1:

$$1.30 \times 1.25 = 162.5.$$

That is, 162.5 is the linked price index in period 2 for oranges when the price is linked to the discontinued orange price index of period 1.

There is one point that should be noted about linking. It is that there is no guarantee that the linked price index will behave in a manner consistent with how the price index of the original item would have behaved. Indeed, there may be reasons to believe that it will not. That is because when one item is substituted for another, it is generally done to take advantage of the expected favorable price trend of the new item compared to that of the old item. (Notice that in the example presented, the linked price [illegible] below the own price.)

The concept of linking is usually applied to a single item. The concept, though, can be extended multiple items when it is called chaining. The two concepts are is virtually identical. The only difference is linking involves a price and chaining involves a price index.

II-C. Changing the Reference Base

As was already indicated in Section II-A, the reference base year of the index and the weight year may differ. In that case the weights used must be changed to reflect prices of the new base year. The methodology outlined here for doing that is used as well when changes have to be made to the historical indexes to reflect changes in the reference base so there will a continuous price index series.

To demonstrate how weights are changed to reflect prices of the base year, use is again made of the apples-oranges data, but with a base year added before period 1. In the example above, the weights were stated in prices of period 1. Now, suppose that purchases of period 1 will continues to serve as the weights, but that the price index is to be expressed in prices of the base year. Suppose the price indexes for apples and oranges are as follows:

	oranges	apples
base year	100	100
period 1	125	110
period 2	187.5	132

(Note: The price indexes for oranges come from the examples above while the previous year's price index for apples of 110 was assumed and the current year's price is derived by multiplying the link relative by that assumed index: 132 = 110 x 1.2.)

Recall from II-A that the weights for apples and oranges in the period 1's prices were respectively, 0.167 and 0.833. For simple items, restating those weights into base year prices would not be very complicated. That would be done as follows: first divide expenditures by the previous period's prices and then multiply them by their base period prices; second, re-derive the weights as above.

Typically, though, this kind of simple calculation cannot be carried out. One reason is that the items whose indexes and weights are being re-referenced are not single items, but rather composites of items, and hence they do not have an identifiable price. For example, oranges could be a composite of a variety of oranges all having different prices. In that case, there is no really identifiable price of the composite. Another reason is that the items being re-referenced did not exist in the base period but are currently being linked into it with other indexes. Again there are not really any identifiable base period prices for those items. Finally, actual expenditures on those items may not be available, but only the base year weights used for compositing their price indexes. In that case there may be neither identifiable prices nor expenditures.

In such situations, the way to change the weights to reflect prices of the base period of the index is to use price index numbers. For apples and oranges that would be done as follows:

expenditures on oranges in base year prices would be:

$$25 \times 100/125 = 20;$$

while the expenditures on apples in base year prices would be:

$$5 \times 100/110 = 4.55.$$

The weight for oranges would then be:

$$20/(20 + 4.55) = .82;$$

while for apples it would be:

$$4.55/(20 + 4.55) = .18.$$

To show how weights in base year prices are derived when expenditure data are not available, we use the apples and oranges weights of the previous year (.17 for apples and .83 for oranges) along with relevant index number data. The weights in base year prices would be computed as follows:

weight for oranges: $(.83/125)/(.83/125 + .17/110) = .82$
weight for apples: $(.17/110)/(.83/125 + .17/110) = .18.$

II-D. Changing the Weight Base: Rebasing

The term *rebasing* refers to changing the weights of the index to reflect new purchasing patterns. The need to rebase arises when the bas˙ ǝt of purchases changes so that it is no longer representative of actual purchases. At the material item level, rebasing is in effect done annually. At the account level, rebasing is carried out every few years. In many way, rebasing and chaining are close relatives.

The demonstration of rebasing will make use of the apples and oranges data of Section II-A and the base year data of II-C. The weight data will reflect base period prices. The weight data of period 2 will be consistent with the set of purchasing patterns for apples and oranges in period 2 but will be in base year prices.

To recap, the following are the price index data being used:

Item:	Oranges	Apples
	Price Indexes	
Base period	100	100
Previous period	125	110
Current period	187.5	132

The followi g are the weight data in base period prices which are derived from the method outline in II-C for restating weights in prices of the base period:

period 1	.82	.18
period 2	.69	.31

Rebasing is done by first computing the previous period index number using the old weights and then using new weights as follows:

$$.82 \times 125 + .18 \times 110 = 122.3$$
$$.69 \times 125 + .31 \times 110 = 120.4.$$

After computing the previous period prices with the new weights, the current period prices are computed with the new weights as follows:

$$.69 \times 187.5 + .31 \times 132 = 170.2.$$

The current period index is then computed as follows:

$$122.3/120.4 \times 170.2 = 172.9.$$

The effect of that computation is to preserve the rate of change of the price index between period 1 and period 2 without allowing the change in weights to affect the index. That can be observed from the following which are the changes from the base period to period 1 and from period 1 to period 2 are as follows:

base period/period 1	period 2/period 1
122.3/100 = 1.223	170.2/120.4 = 1.414

index for period 2/base period:

$$1.223 \times 1.4141 \times 100 = 172.9.$$

Because the ratio 122.3/120.4 is used with the subsequent price indexes that using period 2 weights, it is given a special name. It is called the *link factor* in the sense of linking indexes with one set of weights to those with another set of weights.

APPENDIX

The numerical examples presented in II-A are here presented symbolically. Define P_{oa} as the previous period price of apples, P_{on} as the previous period price of oranges, P_{1a} as the current period price of apples and P_{1n} as the current price of oranges. The current period price indexes would then be as follows:

$P_{1a}/P_{oa} \times 100$ for apples;
$P_{1n}/P_{on} \times 100$ for oranges.

The weights for the indexes would be derived by taking the quantity of apples and oranges purchased in the previous period and valuing those quantities by their respective prices; these are simply the expenditures on apples and oranges. If Q_{oa} and Q_{on} are respectively the quantities of apples and oranges purchased in the previous period then the Laspeyres weights would be as follow:

$w_{aL} = P_{oa} \times Q_{oa}/(P_{oa} \times Q_{oa} + P_{on} \times Q_{on})$ for apples;
$w_{nL} = P_{on} \times Q_{on}/(P_{oa} \times Q_{oa} + P_{on} \times Q_{on})$ for oranges.

To arrive at an overall Laspeyres price index (L) for apples and oranges the weights are applied to the current period price indexes as follows:

$$L = (P_{1a}/P_{oa}) \times w_{aL} + (P_{1n}/P_{on}) \times w_{nL}.$$

Arithmetic manipulation of this formula reduces it to the following:

$$L = (P_{1a} \times Q_{oa} + P_{1n} \times Q_{on})/(P_{oa} \times Q_{oa} + P_{on} \times Q_{on}).$$

What this version of the price index formula says is simply that the price index is the cost, in current prices, of the quantities of apples and oranges purchased in the previous period relative to the cost in the previous period's prices of those quantities. So another way to view a Laspeyres price index is as a measure of how much more it would cost in the current period to purchase a market basket of goods and services that was purchased in a previous period.

The Paasche index is derived with current period weights, restated in previous periods prices. The current period weights are as follows:

$w_{aP} = P_{1a} \times Q_{1a}/(P_{1a} \times Q_{oa} + P_{1n} \times Q_{1n})$ for apples;
$w_{nP} = P_{1n} \times Q_{1n}/(P_{1a} \times Q_{oa} + P_{1n} \times Q_{1n})$ for oranges.

To restate the prices in the weights, we multiply the weights by the inverse of the relatives as follows:

$$w_{aP}' = P_{oa}/P_{1a} \times w_{aP}/((P_{oa}/P_{1a}) \times w_{aP} + (P_{on}/P_{1n}) \times w_{np});$$
$$w_{nP}' = P_{on}/P_{1n} \times w_{nP}/((P_{oa}/P_{1a}) \times w_{aP} + (P_{on}/P_{1n}) \times w_{np}).$$

To arrive at an overall Paasche price index (P) for apples and oranges the restated weights are applied to the current period price relatives as follows:

$$P = (P_{1a}/P_{oa}) \times w_{aP}' + (P_{1n}/P_{on}) \times w_{nP}'.$$

Arithmetic manipulation of this formula reduces it to the following:

$$P = (P_{1a} \times Q_{1a} + P_{1n} \times Q_{1n})/(P_{oa} \times Q_{1a} + P_{on} \times Q_{1n}).$$

What this version of the Paasche price index formula says is simply that the price index is the cost, in current prices, of the quantities of apples and oranges purchased in the current period relative to the cost in the previous period's prices of those quantities. So another way to view a Paasche price index is as a measure of how much more it would cost to purchase a market basket of goods and services that is purchased in the current period relative to the cost of purchasing the same basket in prices of the previous period.

The Fisher's Ideal is a geometric average of the Laspeyres and Paasche as follows:

$$F = L^{1/2} \times P^{1/2}.$$

III. THE AMERITECH TELEPHONE PLANT INDEX - HISTORICALLY

The purpose of this section is to describe in some detail the data sources and methods used for constructing the component portions of the ASITPI.

III-A. The Format and Components of the ASITPI: Uniform Systems of Accounts Revision

The format of the ASITPI is based on the Uniform System of Accounts. The BSTPI was based on an earlier System and when the ASITPI was begun, it used the BSTPI format. On January 1 1988, the Federal Communications Commission (FCC) instituted a revised Uniform System of Accounts (USOA, and hereinafter referred to as the Part 32 rewrite). It required the telephone companies to use that system in tracking their capitalized and expensed costs. When the revision when into effect, the format of the ASITPI was revised as well. The revised USOA affected the ASITPI in the following manner:

1) Electronic switching (77C), was divided into 2 subaccounts - Analog ESS (77C) and Digital ESS (377C);

2) The Circuit Account, while not split out at the subaccount level, allowed for a breakdown for analog and digital circuit equipment which we incorporated into the ASITPI;

3) Aerial Cable was split into two accounts - Other Aerial Cable and Intrabuilding Network Cable;

4) Each cable account (Aerial, Intrabuilding, Underground, and Buried) was split to reflect the company's continuing expenditures on copper cable and to accommodate the increasing expenditures on fiber optic cable;

5) An Operator Systems account was created;

6) Three new General Equipment subaccounts were created - Aircraft, Garage Work Equipment, and Office Support Equipment;

7) A new station account - Other Terminal Equipment - was created for the channel terminating equipment that was formerly part of Large PBX; and,

8) Portions of the labor expenditures which previously had been capitalized were now to be expensed.

III-B. Change in Reference Base

As part of the process of incorporating the USOA changes into the existing structure of the telephone plant index, the reference base for all indexes was changed from 1977 = 100 to 1988 = 100. The weight base for the index was also changed from 1977 constant dollars to 1988 constant dollars. What that means is discussed in Section III-J. Expenditure Weights.

III-C. General Outline of the ASITPI

The ASITPI is composed of accounts and sub-accounts. The accounts can be grouped into five major categories: Buildings, Central Office Accounts, Station Accounts, Outside Plant Accounts and, finally, General Equipment accounts. The account indexes are based on sub-accounts indexes and many but not all the sub-account indexes are based on price indexes for components within the sub-account. Usually, there are five such components. They are: Telco labor, Telco engineering, vendor labor, vendor engineering and materials. Some of the outside plant accounts also include contract labor. Each of the next sections describes how the price are acquired and transformed into price indexes for each of those components.

III-D. Development of Material Indexes for Central Office Equipment

III-D.1. General Information on Data Sources and Index Development

A major portion of the central office (COE) accounts is based on material indexes developed by Joel Popkin and Company. Beginning in 1988, a new database for the COE accounts was available from which to compute the material indexes. That data base is know as the Billing Verification and Payment Processing System (BVAPPS) and it contains purchases of COE equipment. It comprises two parts - Hardwire Equipment and Plug-In Equipment. The data are then further divided by Field Reporting Code (FRC). The FRCs correspond to the account where the material is used. The FRCs used for developing the COE indexes are as follows:

FRC		Subaccount
77C	-	Analog ESS
377C	-	Digital ESS
57C	-	Other Analog Circuit
157C	-	Digital Data Systems
257C	-	Digital Sub Pair Gain
357C	-	Other Digital Circuit Equipment
457C	-	Analog Sub Pair Gain
67C	-	Radio

BVAPPS is, by far, the most complete source of data for COE that we have found in Ameritech Services. Like most data sets, it has its limitations. Awareness of those limitations allows us to use only the information that is relevant to the ASITPI and to make corrections where necessary. The various limitations have led to a great deal of software development whose purpose it is to edit the BVAPPS data before they are read by programs that do the index calculations that produce the index.

Two kinds limitations have been encountered in the use of the BVAPPS data which have required extensive editing. One limitation is incomplete or incorrect entry of descriptors that are used for matching items. Insofar as the descriptor is the identifier used for determining whether entries in the BVAPPS are one kind of item or another, and insofar as a computer program calculates the index, it becomes extremely important that all entries for each kind of item have precisely the same descriptor. An example would be the use of the descriptors "ASSY" and "ASSEMBLY." Both refer to an assembly, but, when the computer matches the two descriptors, could treat them as different items unless it is programmed to realize that they are the same. Another limitation is the incorrect recording of quantities. The consequence of that is that prices for the same descriptor are not comparable. Frequently, though, that problem is solvable by means that will be described below. A final limitation is that sometimes several items are combined into one. That is especially the case for items that are know as J-codes and ED-Codes. Frequently, those codes contain several components known as lists (Ls). The individual L(ist) prices must then be backed out of the total shown for the item or, failing that, the item must be matched on an item with the same array of lists, and when none of those are possible, the item must be excluded from the index.

Another limitation about the data in BVAPPS relates to the different pricing trends that can be seen for the same item in the same time period. Some of those different trends are from inaccuracies in quantity reporting, and are easily corrected. However, it is not improbable or impossible to observe different price levels. Competition, inventory levels, volume discounts, and switch size can all affect an item's prices. Thus, the same item can have a different price depending on how it is purchased. For example, a Northern Telecom circuit pack could be purchased at least three different ways: 1) with the initial switch hardwire equipment; 2) directly from the vendor in an order subsequent to the hardwire equipment; or, 3) in bulk through a centralized plug-in group. Each purchasing method will yield a different price. When continuous, different price levels are observed for an item, the item can essentially be treated as different items. That allows us to reflect the different price tracks that Ameritech Services can use to purchase an item.

The above deficiencies of BVAPPS are expressed solely to present a full picture of the problems encountered with many databases. Those deficiencies do not, however, negate the tremendous advantages derived by using BVAPPS (or any other large database).

The steps taken in the development of material price indexes for the COE accounts as developed from the BVAPPS by FRC is as follows. Ameritech sends Joel Popkin and Co. BVAPPS data by tape or floppy disk. The data then undergo an extensive editing process to correct for units problems and incomplete/aggregated product descriptions. After the data have been edited, each item is assigned to the appropriate account by its field reporting code. The items within an account are then sorted by like vendors and like descriptors. A program then reads the data and calculates material price indexes by FRC for Hardwire or Plug-In for each account. After deriving indexes for each account by Hardwire and Plug-In component, the two indexes are weighted together to derive the overall index (or index relative) for the FRC listed above. The weights used for the separate Hard-wire and Plug-In component indexes are based on dollar expenditures on the Hard-wire component and on the Plug-in component taken from the BVAPPS data for the account.

The following conditions affect the construction of the index:

1) Because the technology in most accounts is changing so rapidly, the basket of materials used in the index is changed annually;

2) Because of the possibility of index drift, the use of a Fisher's Ideal was instituted in 1992;

3) Because BVAPPS tracks most COE items and is in electronic format, it eliminates the need for sampling and allows for more complete tracking of items; and

4) For the same reason, it is possible to update constantly the material price indexes thereby allowing for the incorporation of new technology into the index as soon as material incorporating the new technology is purchased in sufficient quantity.

Because of the constantly changing mix of equipment in COE, the basket of items is changed annually and a linked index is calculated; that type of index allows us to incorporate the newest technology as it enters the purchasing stream. Also, because of the continuing change in the market basket, certain rules are used about whether to include an item in the index or to exclude. The primary rule is that for an item to be included in the index calculation, the item must have been purchased in at least two adjacent years. If that condition is not met, the item is not used in the index calculation. For example, an item purchased only in 1989, 1990 and 1992 would be included in the index only for 1989 and 1990.

For items that are in two adjoining years, the calculation of the linked index is as follows: For each item, the geometric average prices are computed for each year; from the geometric average, a price relative of the previous year's prices is computed; the price relative is weighted by the previous year's weights and a Laspeyres index is computed from the weighted price relatives; then a Paasche index is computed using current year weights; then a Fisher's Ideal is computed based on the geometric average of the Paasche and Laspeyres. The resulting index is essentially a price relative at the index level. It is then linked to the previous year's index number.

III-D.1. Specific Central Office Materials Account Detail

The above description of the use of the BVAPPS database to develop the Central Office materials indexes does not address specifically any account. While the methodology is the same for each account, there are a few specifics that need to be addressed by account.

III-D.1.a. Electronic Switching

One of the major features of the Part 32 rewrite was splitting the former 77C-Electronic Switching subaccount into two new subaccounts - Analog Switching and Digital Switching.

Analog switching is the older switching technology and Ameritech's expenditures on that type of equipment are falling rapidly. Because it is a dying technology, the Analog ESS materials index constructed from BVAPPS is used as a proxy for the materials portion of the Step-By-Step and Crossbar accounts.

Ameritech continues to invest a large portion of its expenditures - about 20 percent - in Digital ESS. Using BVAPPS allows us to introduce new vendors and new types of equipment into the materials index very rapidly.

III-D.1.b. Circuit Equipment

While it was not mandated by the FCC, enough information was available starting in 1988 to divide the Circuit subaccount into smaller components - Analog Circuit, Other Digital Circuit, and Digital Sub Pair Gain Circuit. Each component has its own weights for Telco Labor, Telco Engineering, and Loaded Material. The three components are then aggregated to derive an overall circuit composite.

III-D.1.c. Radio

Radio materials prices are also collected from the BVAPPS system. Because expenditures on radio are so small, only a plug-. index can be constructed for radio.